# Standard Open Microdiscectomy versus Minimal Access Trocar Microdiscectomy: Results of a Prospective Randomized Study

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**OBJECTIVE:** Minimal access surgery as a less invasive alternative to standard macro- and microsurgical approaches is becoming increasingly popular in the management of traumatic and degenerative spine diseases. However, data is lacking if minimal access spine surgery is indeed beneficial. This prospective randomized study was conducted to compare efficiency, safety, and outcome of standard open microsurgical discectomy (SOMD) for lumbar disc herniation with microsurgical discectomy using an 11.5 mm trocar system for minimal access to the spine.

**METHODS:** Sixty patients were randomized to two groups of 30 patients each. Group 1 was treated by SOMD, and Group 2 was treated by minimal access microsurgical discectomy (MAMD). Perioperative parameters and pre- and postoperative clinical findings including sensory or motor deficits and pain according to the visual analog scale, Oswestry Disability Index scores, and Short Form-36 results were assessed. All patients were followed for at least 6 months postoperatively (mean, 16 mo).

**RESULTS:** Preoperatively, no statistically significant intergroup differences could be detected proving the comparability of both groups. Postoperatively, significant improvement of neurological symptoms and pain as measured by the visual analog scale, Oswestry Disability Index, and Short Form-36 scores could be achieved in both groups. In regard to operative time, intraoperative blood loss, and complication rate, slightly better results were observed in the MAMD group.

**CONCLUSION:** SOMD and MAMD allow achievement of significant improvement of pain and neurological deficits in patients with lumbar disc herniations. Differences in operative time, blood loss, and complication rates were statistically not significant in MAMD compared with SOMD, indicating that, at least in lumbar disc surgery, minimal access trocar techniques are a viable alternative to standard spinal approaches.

**KEY WORDS:** Lumbar disc herniation, Minimal access spine surgery, Minimally invasive spine surgery

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Open microsurgical discectomy as the standard operative technique for lumbar disc herniations was established in Europe in 1977 by Caspar (3) and Yaşargil (40) and by Williams (38) and Wilson and Kenning (39) in the United States in 1978 and 1979, respectively. A trend to even less invasive techniques gave way to a wide variety of truly percutaneous methods such as chemonucleolysis (35), percutaneous manual nucleotomy (16), automated percutaneous lumbar discectomy (25), laser discectomy (1), and intradiscal electrothermy (27). These methods are all performed without direct visual control and with only fluoroscopic guidance, which might explain the low rate of good results (45–69%) (6, 15, 20, 36). This paved the way for the development of percutaneous endoscopic techniques (31). A limitation of percutaneous endoscopic discectomy was the restriction to those instruments that can be introduced through the working channel of the endoscope. Therefore, endoscopy was combined with tubular retractors and trocar systems, in which the endoscope was only used for visualization while the operative steps were done with the common microsurgical instruments. With increasing use of endoscopes for spine surgery, the disadvan-

tage of the two-dimensionality of the endoscopic image became increasingly obvious. To overcome the problem of two-dimensionality, the tubular retractors and trocar systems recently were combined with the use of the microscope (14). These endoscopic and microscopic trocar techniques were generally combined under the term "minimally invasive spine surgery" or, more precisely, "minimal access spine surgery" (10).

In theory, the reduction of tissue trauma by minimization of the access to spine and disc herniation should be of benefit for the patient. However, prospective randomized trials comparing standard microscopic discectomy with minimal access trocar techniques are still lacking. Therefore, the purpose of this current prospective randomized study was to compare standard microdiscectomy with a novel minimal access muscle-splitting approach and microscopic disc material removal in regard to efficiency, safety, and clinical outcome.

## PATIENTS AND METHODS

### Patient Selection

The study protocol was fully approved by the institutional ethics committee. All patients provided written informed consent and underwent operation by board-certified neurosurgeons with extensive experience (≥6 yr) in lumbar spine surgery to minimize differences in surgical outcome due to varying surgical experience. Only patients who fulfilled the following criteria were included: 1) single level virgin lumbar disc herniation; 2) typical monoradicular symptoms attributable to the involved lumbar segment with predominant sciatica compared to less severe lower back pain; and 3) failure of 8 to 12 weeks of conservative treatment, intolerable sciatica, or rapidly progressive neurological deficits including motor deficits, bladder dysfunction, and cauda equina syndrome. Exclusion criteria consisted of: 1) history of previous lumbar back surgery or conservatively treated lumbar disc herniation at adjacent levels; 2) signs of spinal instability or other spinal abnormalities such as bone disease, spinal infection, malignancy, or signs of spinal canal stenosis on computed tomography or magnetic resonance imaging and neurogenic claudication; 3) intra- and extraforaminal far lateral disc herniation; 4) excessive obesity; 5) chronic pain syndrome and opioid abuse; 6) history of psychiatric or psychological disorder; 7) ingestion of anticoagulants; and 8) pending workers' compensation.

For data analysis, 60 consecutive patients were recruited from June 2004 to August 2006. Only patients fulfilling all inclusion criteria were blindly randomized to the SOMD or MAMD groups.

The authors believe that relief of symptoms in patients experiencing cauda equina syndrome need not be treated by complete laminectomy. Instead, these patients can be adequately decompressed by partial hemilaminectomy and removal of the herniated disc material (4).

### Patient Evaluation

#### *Preoperative Assessment*

Preoperative neurological deficits and pain was measured according to a self-assessment 10-point visual analog scale (VAS) (32). Physical and mental health symptoms were measured using the Oswestry Disability Index (ODI) (8) and Short Form-36 (SF-36) questionnaire (37).

#### *Intraoperative Parameters*

The duration of surgery and intraoperative blood loss were measured. If present, intraoperative complications were documented.

#### *Statistical Analysis*

All values are expressed as the means ± standard deviations. Intergroup differences concerning pre- and postoperative data were analyzed using the Mann-Whitney *U* test. Statistical significance was set at a $P$ value less than 0.05.

### Surgical Technique

All procedures were performed under general anesthesia in a standardized manner. The patient was placed in a prone position with flexed hips and knees in a 90-degree angle and knees positioned on individual knee rests to reduce lordosis of the lumbar spine.

#### *Standard Open Microdiscectomy*

A standard Caspar microsurgical retractor (Lumbar Spine Classics; Aesculap, Tuttlingen, Germany) was used in lengths ranging from 40 to 65 mm. The skin was incised horizontally over a length of 4 to 5 cm on the affected side after localization of the interlaminar space with lateral x-ray fluoroscopy. The lumbodorsal fascia was incised vertically over a distance of 4 to 5 cm, 0.5 cm paramedially. The paraspinal musculature was partially detached from the hemilamina in a subperiostal fashion, the interlaminar space was visualized, and the retractor placed into position. A second fluoroscopy was obtained to confirm the correct level. The operating microscope (Carl Zeiss Co., Oberkochen, Germany) was put into position and the remaining operation performed in the standard microsurgical fashion with bayoneted microsurgical instruments. Partial hemilaminectomy of the superior and inferior lamina and medial facetectomy with different size drills and Kerrison punches, followed by a partial flavectomy, were carried out to visualize the thecal sac and the compromised nerve root. Epidural veins were coagulated with a bipolar forceps and the nerve root carefully retracted medially to identify the herniated disc fragments. The herniated sequester was removed and the posterior longitudinal ligament inspected. In cases of a sizable defect in the posterior longitudinal ligament and fibrous annulus of the intervertebral disc, a partial nucleotomy was performed to remove the degenerated parts of the pulpous nucleus in the intradiscal space with different size rongeurs. Hemostasis was obtained with bipolar forceps and saline irrigation. Wound closure consisted of five to six fascial sutures and subcutaneous stitches. The skin was dressed with Steri-Strips (Steri-Strip; 3M HealthCare, St. Paul, MN) and an adhesive bandage.

#### *Minimal Access Trocar Microdiscectomy*

A trocar, with an enclosed bluntly tipped mandrin surpassing the tip of the trocar by 1.5 cm and a detachable handle, was manufactured at our institutional medicinal workshop. The trocar was manufactured in lengths of 40, 50, 60, and 70 mm with an inner diameter of 11.5 mm (*Fig. 1*). After localization of the interlaminar space with lateral x-ray fluoroscopy (*Fig. 2*), a skin incision measuring 1.6 cm in length was performed 1.5 cm paramedially. The lumbodorsal fascia was bluntly dissected and the trocar, together with the enclosed mandrin, was gently screwed into the paraspinal muscles in a slightly oblique direction in a clockwise fashion until the interlaminar window was reached, with the tip of the mandrin pointing medially (*Fig. 3*). In this way, the paraspinal muscle attachments to the laminae and spinous processes could be well preserved in their full

**FIGURE 1.** *Trocar with attached handle.*

**FIGURE 2.** *Lateral x-ray fluoroscopy showing the inserted trocar.*

integrity. The mandrin was removed and the handle attached to the trocar. Outer threads on the working channel provided secure positioning, preventing dislocation by slipping of the trocar. After a second fluoroscopy, further surgery was performed with the aid of the operative microscope (Carl Zeiss Co.) with microsurgical bayoneted instruments. After exposure of the interlaminar space a minimal interlaminar fenestration was performed by use of drills or different size Kerrison punches, but only if necessary. In cases of a wide interlaminar space, interlaminar fenestration was omitted and surgery continued with a minimal partial flavectomy. That way, the amount of bony resection could be individually tailored and reduced to a minimum. Further surgery was conducted similarly to SOMD. The nerve root was retracted medially, the herniated disc material removed, and, if necessary, a partial discectomy performed. Hemostasis was redundant in most cases. After counterclockwise removal of the trocar, the wound was closed with one or two subcutaneous stitches; no fascial sutures were necessary. Steri-Strips and an adhesive bandage finished the operation.

### *Postoperative Evaluation*

Neurological symptoms and pain as measured by the VAS were obtained at the time of discharge. Patients were routinely evaluated 6 to 8 weeks after surgery by an independent examiner. At a follow-up examination 6 to 26 months after surgery (mean, 16 mo), VAS, ODI, and SF-36 scores were acquired using the same standardized questionnaires.

## RESULTS

### *Demographic and Clinical Data*

For data analysis, 30 patients each were randomized to the SOMD and MAMD groups (*Table 1*). All patients experienced lumbar disc herniations at the L4–L5 and L5–S1 levels. The mean age at the time of surgery was 39 years (range, 21–69 yr) in the standard group and 38 years (range, 23–62 yr) in the trocar group. As proven by $P$ values greater than 0.05, no significant differences in baseline demographic data, clinical profiles, or preoperative pain was found according to the VAS, ODI, and SF-36 scores in both study groups. The mean preoperative VAS scores were 7.3 ± 2.3 (range, 1–10) and 6.9 ± 2.4 (range, 0–10) in the standard and trocar groups, respectively. The mean preoperative ODI score in the SOMD group was 56.7 ± 23.1 (range, 8–96) and 53.1 ± 19.2 (range, 26–92) in the MAMD group. SF-36 scores on admission were low, especially for subscales physical functioning, role physical functioning, and bodily pain.

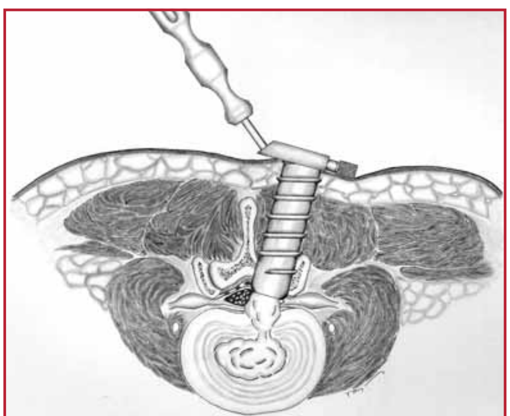

**FIGURE 3.** *Pencil drawing showing the trocar with attached handle in situ.*

### *Intraoperative Parameters*

The mean operative time was 92 ± 28.6 minutes (range, 33–150 min) in the SOMD group and 82 ± 25.1 minutes (range, 37–120 min) in the MAMD group ($P = 0.23$). The average intraoperative blood loss was 63.8 ± 86.8 mL (range, 0–300 mL) in the standard group and 26.2 ± 29.7 mL (range, 0–100 mL) in the trocar group ($P = 0.31$). The mean and maximum operative times and intraoperative blood loss were lower in the MAMD group. Nevertheless, the data concerning these intraoperative parameters were not statistically significant, probably due to the high standard deviations.

### *Complications and Repeated Surgery*

Three recurrent disc herniations requiring repeat surgery were observed in the SOMD group after 2, 7, and 14 months compared with one early recurrence requiring a second operation 6 weeks after initial surgery in the MAMD group. Residual disc herniations occurred in one patient each in the SOMD and MAMD groups. These were treated by repeat surgery during the initial hospital stay. Two patients in the SOMD group experienced a dural tear without further sequelae, whereas no incidental durotomy was observed in the MAMD group (*Table 2*).

### *Clinical Outcome*

After a follow-up period of 6 to 26 months (average, 16 mo), the mean VAS was 2.1 ± 2.4 (range, 0–9.8) in the SOMD group and 2.1 ± 2.4 (range, 0–7.5) in the MAMD group (*Tables 3–7*). The mean ODI improved to 12 ± 18.8 (range, 0–86) in the SOMD group and 12 ± 14 (range, 0–46) in the MAMD group. Improvements of VAS and ODI scores were statistically significant in both groups ($P = 0.0$) with a tendency toward a slighty better outcome in the MAMD group. Evaluation of SF-36 component summary and subscale scores showed a highly significant improvement during the follow-up period compared with the preoperative data in both groups in most of the subscale and component summary scores.

## DISCUSSION

### *Studies Comparing SOMD and MAMD*

We report our results of a prospective randomized study comparing two different surgical approach techniques, SOMD

**TABLE 1.** Demographic data of 60 prospectively randomized patients with lumbar disc herniation

| Parameters | Standard microdiscectomy | Trocar microdiscectomy | *P* value |
|---|---|---|---|
| No. of patients | 30 | 30 | |
| Age, yr (mean ± standard deviation) | 39.1 ± 11.3 (21–69) | 38.2 ± 9.3 (23–62) | 1.0 |
| Male/female ratio | 19/11 | 13/17 | 0.12 |
| Level | | | 0.61 |
| *L4–L5* | 14 | 12 | |
| *L5–S1* | 16 | 18 | |

**TABLE 2.** Surgical data of 60 prospectively randomized patients with lumbar disc herniation

| Parameters | Standard microdiscectomy, mean ± standard deviation (range) | Trocar microdiscectomy, mean ± standard deviation (range) | *P* value |
|---|---|---|---|
| Operating time (min) | 92 ± 28.6 (33–150) | 82 ± 25.1 (37–120) | 0.23 |
| Blood loss (ml) | 63.8 ± 86.8 (0–300) | 26.2 ± 29.7 (0–100) | 0.31 |
| Postoperative hospital stay (d) | 4.4 ± 2.8 (1–15) | 4 ± 2.3 (2–14) | 0.51 |
| Skin incision (cm) | 4–5 | 1.6 | 0 |
| Complications | 6 (20%) | 2 (7%) | 0.14 |
| *Dural tear* | 2 | 0 | |
| *Residual disc herniation* | 1 | 1 | |
| *Recurrent disc herniation* | 3 | 1 | |
| Resurgery | 4 | 2 | |

and MAMD, for the treatment of symptomatic lumbar disc disease. Analysis of our results indicates improvement of pain and functional outcome scores after SOMD and MAMD. Significant relief of motor deficits, sensory deficits, and pain as measured by the VAS scores, ODI scores, and SF-36 scales could be achieved postoperatively in both groups. No statistically significant difference could be demonstrated between the SOMD and the MAMD groups regarding duration of hospital stay and postoperative improvement of VAS, ODI, and SF-36 scores. Different from the United States, the mean length of hospitalization in Germany currently averages 6 days (range, 1–15 d) for lumbar disc surgery according to the data of the medicoeconomic classification (German Diagnosis Related Groups) of the German healthcare system. Therefore, in both groups mean hospital stay was considerably lower (SOMD, 4.4 d; MAMD, 4 d) compared to the average. A tendency in favor of the SOMD group could be comprehended concerning the SF-36 mental component summary score and the subscales general health perception and role-emotional functioning. Even though patients were blindly randomized, they could determine to which group they were randomized after surgery by the length of their skin incision. Therefore, we attributed these differences in SF-36 scores to a probable psychological "guinea pig" effect caused by comparison of a widespread established surgical procedure to a new, less common, and seemingly "experimental" approach. Better results in regard to operative time, intraoperative blood loss, complication rate (dural tear: SOMD, 2; MAMD, none) and resurgery for residual or recurrent disc herniation (SOMD, 4 [13%]; MAMD, 2 [7%]) could be achieved in the MAMD group, although these results were not statistically significant.

To the best of our knowledge, there is only one other study comparing SOMD and MAMD; that study has the substantial flaw that the authors compared a historical group of SOMD patients with a contemporary consecutive series of patients undergoing MAMD (14). Despite the inferior study design, results that are almost similar to ours in many aspects are reported by Greiner-Perth et al. (14). In their series, mean operative times were slightly longer in the MAMD group (69 min) compared with the SOMD group (63 min). Additionally, they reported four dural tears in the trocar group, which they attributed to the steep learning curve of this procedure. In our study, there were no dural tears observed in the MAMD group, possibly because the trocar was already used routinely before initiation of the present study. Similar to our results, the amount of blood loss was markedly lower in the trocar group. In respect to recurrent disc herniations, the recurrence rate of MAMD was 4.5%. No data are provided concerning the recurrence rate in SOMD (13). In our study, we experienced a slightly higher recurrence rate (MAMD, 7%; SOMD, 13%), which might be explained in part by the prospective study design.

In summary, our data and those of Greiner-Perth et al. (14) indicate that MAMD delivers results which are similar or even in tendency better than those of SOMD for herniated lumbar disc. It

**TABLE 3.** Visual analog scale, Oswestry Disability Index, and neurological symptoms preoperatively and at follow-up

| Parameters | Standard microdiscectomy, mean ± standard deviation (range) | Trocar microdiscectomy, mean ± standard deviation (range) | *P* value |
|---|---|---|---|
| Visual analog scale | | | |
| *Preoperative* | 7.3 ± 2.3 (1–10) | 6.9 ± 2.4 (0–10) | 0.60 |
| *Follow-up* | 2.1 ± 2.4 (0–9.8) | 2.1 ± 2.4 (0–7.5) | 0.86 |
| Oswestry Disability Index | | | |
| *Preoperative* | 56.7 ± 23.1 (8–96) | 53.1 ± 19.2 (26–92) | 0.48 |
| *Follow-up* | 12 ± 18.8 (0–86) | 12 ± 14 (0–46) | 0.83 |
| Symptoms | | | |
| *Radicular pain* | | | |
| Preoperative | 29 (97%) | 27 (90%) | 0.31 |
| Follow-up | 5 (17%) | 1 (3%) | 0.11 |
| *Sensory deficits* | | | |
| Preoperative | 22 (73%) | 27 (90%) | 0.1 |
| Follow-up | 13 (43%) | 12 (40%) | 0.31 |
| *Motor deficits* | | | |
| Preoperative | 15 (50%) | 16 (53%) | 0.61 |
| Follow-up | 7 (23%) | 8 (27%) | 0.86 |
| *Bladder dysfunction* | | | |
| Preoperative | 1 (3%) | 2 (7%) | 0.56 |
| Follow-up | 0 | 0 | 1 |

**TABLE 4.** Short Form-36 physical and mental component summary scores preoperatively and at follow-up

| Summary score | Standard microdiscectomy, mean ± standard deviation (range) | Trocar microdiscectomy, mean ± standard deviation (range) | *P* value |
|---|---|---|---|
| Physical component summary | | | |
| *Preoperative* | 27.3 ± 5.9 | 29.3 ± 7.8 | 0.44 |
| *Follow-up* | 47.5 ± 9.4 | 47.6 ± 10.7 | 0.79 |
| Mental component summary | | | |
| *Preoperative* | 42.3 ± 14.8 | 39.5 ± 12.4 | 0.51 |
| *Follow-up* | 51.9 ± 7.8 | 44 ± 13.2 | 0.03 |

can be assumed that the minimal skin incision and minimized operative trauma of the paraspinal musculature and bony structures of the vertebral column in MAMD contribute to the favorable results with less postoperative low back pain and less iatrogenic devascularization and denervation of paraspinous muscles (14, 26, 33). This concept is supported by an intraoperative electromyographic study indicating that trocar access reduces nerve root irritation due to intraoperative excessive nerve root retraction (29) and by a laboratory study by Sasaoka et al. (28) in which the level of the inflammatory markers C-reactive protein, interleukin-6 and interleukin-10, were lower in the minimal access group than in the SOMD group. In contrast, Muramatsu et al. (21) did not demonstrate any difference in grade of invasiveness comparing the trocar technique with standard microdiscectomy in a magnetic resonance imaging. The cosmetic aspect of MAMD had been beyond the scope of our investigation, but should likewise be considered in future studies on SOMD and MAMD.

### *Other SOMD Studies*

The SOMD results of the present study are comparable with the results of investigations that focus on SOMD exclusively. The recurrence rate of standard microdiscectomy varies between 3 and 18% (2, 5, 9, 12, 17, 19, 20, 24, 34, 38), and the rate of good to excellent results between 81 and 91%, depending on

**TABLE 5. Short Form-36 subscale scores preoperatively and at follow-up**

| Subscales | Standard microdiscectomy, mean ± standard deviation (range) | Trocar microdiscectomy, mean ± standard deviation (range) | *P* value |
|---|---|---|---|
| Physical functioning | | | |
| *Preoperative* | 28.5 ± 26.1 | 33 ± 23.6 | 0.45 |
| *Follow-up* | 80.4 ± 19.6 | 74.8 ± 23.3 | 0.64 |
| Role-physical functioning | | | |
| *Preoperative* | 14.5 ± 28.7 | 11 ± 20.5 | 0.87 |
| *Follow-up* | 73.2 ± 37.3 | 66.3 ± 41 | 0.55 |
| Bodily pain | | | |
| *Preoperative* | 19.1 ± 17.3 | 22.4 ± 22.8 | 0.84 |
| *Follow-up* | 70.2 ± 25.1 | 68.9 ± 31.9 | 0.95 |
| General health perception | | | |
| *Preoperative* | 56.5 ± 23.7 | 56 ± 22.2 | 0.79 |
| *Follow-up* | 73.2 ± 18.9 | 67.4 ± 20.1 | 0.19 |
| Vitality | | | |
| *Preoperative* | 32.8 ± 24.9 | 32.5 ± 21.8 | 1.0 |
| *Follow-up* | 59.6 ± 20.8 | 51.5 ± 20.1 | 0.17 |
| Social functioning | | | |
| *Preoperative* | 46.5 ± 30 | 44 ± 32.5 | 0.67 |
| *Follow-up* | 88.4 ± 18 | 78.3 ± 27.2 | 0.18 |
| Role-emotional functioning | | | |
| *Preoperative* | 43 ± 48.1 | 38.7 ± 45.8 | 0.8 |
| *Follow-up* | 85.2 ± 31.1 | 60.6 ± 46.7 | 0.03 |
| Mental health index | | | |
| *Preoperative* | 54.3 ± 24 | 47.8 ± 21 | 0.34 |
| *Follow-up* | 75.1 ± 14.9 | 61.9 ± 24.3 | 0.1 |

the length of follow-up and the study design (12, 13, 17, 18, 19, 20, 38). Thus, our finding that MAMD yields slightly better results than SOMD is not biased by inadequate or poor SOMD results in our series.

### *Studies on Minimal Access Endoscopic Discectomy*

A prospective evaluation of 135 patients who underwent endoscopically controlled microdiscectomy via a trocar system (microscopic endoscopic tubular retractor system microdiscectomy) yielded results similar to our MAMD results concerning intraoperative parameters (mean operative time, 66 min; mean blood loss, 22 mL), recurrent disc herniation rate (four recurrent disc herniations, five reoperations) and outcome (94% satisfactory operative results; VAS scores, 7–2; ODI scores, 56–16; SF-36 bodily pain subscore, 20–60) (23). The durotomy rate (three durotomies) seems to be slightly higher.

Another recent small prospective study with an average follow-up period of 12 months could prove the same effectiveness of microendoscopic discectomy compared with standard microsurgical discectomy of uncontained or large herniated discs (30). No differences in length of hospital stay or outcome were found by assessment of ODI scores and low back pain outcome scores. In addition, there was a significantly lower demand of oral analgesics. In the authors' opinion patients experiencing excessive obesity or herniated discs surpassing more than one vertebral level might be unsuitable for this kind of approach and should undergo SOMD.

Different from the METRx-MD system (METRx; Medtronic Sofamor Danek, Minneapolis, MN), MAMD's muscle-splitting approach is not facilitated by dilation of the paraspinous musculature by sequential dilators. Using its screw thread, the trocar with its tapered mandrin can be brought into the paraspinous muscles directly without the need for a K-wire; this eliminates the risk of accidental durotomy or nerve root lesion (11, 25, 26).

No studies exist that compare MAMD with minimal access endoscopic discectomy. The scarce data suggest that similar results can be obtained with both minimal access techniques. For us, one advantage of MAMD compared with endoscopic trocar procedures is that it encompasses the same microsurgical technique with three-dimensional visualization of the operating target and use of the same or similar microsurgical instru-

**TABLE 6. Improvement of postoperative visual analog scale, Oswestry Disability Index, and Short Form-36 in the standard microdiscectomy group**

| | Preoperative, mean ± standard deviation | Postoperative, mean ± standard deviation | *P* value |
|---|---|---|---|
| Visual analog scale | 7.3 ± 2.3 | 2.1 ± 2.4 | 0 |
| Oswestry Disability Index | 56.7 ± 23.1 | 12 ± 18.8 | 0 |
| Short Form-36 | | | |
| *Physical component summary score* | 27.3 ± 5.9 | 47.5 ± 9.4 | 0 |
| *Mental component summary score* | 42.3 ± 14.8 | 51.9 ± 7.8 | 0.01 |
| Subscales | | | |
| *Physical functioning* | 28.5 ± 26.1 | 80.4 ± 19.6 | 0 |
| *Role-physical functioning* | 14.5 ± 28.7 | 73.2 ± 37.3 | 0 |
| *Bodily pain* | 19.1 ± 17.3 | 70.2 ± 25.1 | 0 |
| *General health perception* | 56.5 ± 23.7 | 73.2 ± 18.9 | 0.003 |
| *Vitality* | 32.8 ± 24.9 | 59.6 ± 20.8 | 0 |
| *Social functioning* | 46.5 ± 30 | 88.4 ± 18 | 0 |
| *Role-emotional functioning* | 43 ± 48.1 | 85.2 ± 31.1 | 0 |
| *Mental health index* | 54.3 ± 24 | 75.1 ± 14.9 | 0 |

**TABLE 7. Improvement of postoperative visual analog scale, Oswestry Disability Index, and Short Form-36 in the trocar microdiscectomy group**

| | Preoperative, mean ± standard deviation | Postoperative, mean ± standard deviation | *P* value |
|---|---|---|---|
| Visual analog scale | 6.9 ± 2.4 | 2.1 ± 2.4 | 0 |
| Oswestry Disability Index | 53.1 ± 19.2 | 12 ± 14 | 0 |
| Short Form-36 | | | |
| *Physical component summary score* | 29.3 ± 7.8 | 47.6 ± 10.7 | 0 |
| *Mental component summary score* | 39.5 ± 12.4 | 44 ± 13.2 | 0.26 |
| Subscales | | | |
| *Physical functioning* | 33 ± 23.6 | 74.8 ± 23.3 | 0 |
| *Role-physical functioning* | 11 ± 20.5 | 66.3 ± 41 | 0 |
| *Bodily pain* | 22.4 ± 22.8 | 68.9 ± 31.9 | 0 |
| *General health perception* | 56 ± 22.2 | 67.4 ± 20.1 | 0.09 |
| *Vitality* | 32.5 ± 21.8 | 51.5 ± 20.1 | 0.003 |
| *Social functioning* | 44 ± 32.5 | 78.3 ± 27.2 | 0.001 |
| *Role-emotional functioning* | 38.7 ± 45.8 | 60.6 ± 46.7 | 0.11 |
| *Mental health index* | 47.8 ± 21 | 61.9 ± 24.3 | 0.04 |

ments as applied in SOMD. This ensures a broad availability of this procedure to spine surgeons and avoids the hurdle of learning a completely new surgical technique such as endoscopic nucleotomy. The 0% rate of durotomies in our MAMD series possibly supports this aspect. Nonetheless, the trocar technique is technically more demanding than SOMD and, therefore, is not suitable for inexperienced spine surgeons.

### *Limitations and Benefits of the Study*

One limitation of this study is the relatively short mean follow-up period of 16 months. Longer follow-up periods may show a deterioration of symptoms with a tendency towards an aggravation of outcome. However, the other studies addressing endoscopic and microscopic trocar procedures have even shorter follow-up times. The limited patient number of 60 patients may result in a limited statistical power of this study. Furthermore, the present study is based on a selected patient cohort and its results cannot currently be generalized for the entire patient population undergoing surgery for lumbar disc herniations at our institution during the examined time period.

This is the first prospective randomized study that compares SOMD with a trocar procedure. The prospective ran-

domized nature of this study eliminates the possibility of patient selection in favor of one group or the other, leading to a homogenous patient cohort, thus allowing an excellent comparability of both examined groups. The standard protocol, with its strict inclusion and exclusion criteria, rules out differences and bias in outcome due to accompanying spinal pathologies or accompanying illnesses and sociomedical factors. Furthermore, the thorough examination of pre- and postoperative symptoms, pain, and general health by standardized questionnaires and scales led to valid results that are comparable to other studies.

## CONCLUSION

MAMD yields results comparable to SOMD concerning improvement of neurological symptoms, pain relief, length of hospital stay, and quality of life. A trend toward superior results after MAMD could be observed in regard to operative time, blood loss, and complication rates. However, results were not statistically significant. In addition, MAMD enables less invasiveness and a smaller skin incision ensuring excellent cosmetic results. The results of the present study indicate that MAMD is a viable alternative to SOMD in patients with lumbar disc herniations.

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## COMMENTS

The authors studied 60 patients with lumbar disc herniation who were randomized into two groups of 30 patients each. Group 1 was

treated by standard open microdiscectomy; Group 2 was treated by minimal access microsurgical discectomy (MAMD).

The results were basically similar. Although not statistically significant, there was less blood loss and shorter operative times in those patients who underwent MAMD.

The authors concluded that both procedures led to excellent recovery and that the minimal access technique is a viable alternative to standard spinal approaches. I agree with this assessment. However, there is somewhat of a learning curve in performing MAMD. It is interesting to note that the MAMD group reported in this series actually had shorter surgical times. Because this procedure is relatively new, it initially leads to longer operative times. However, the discrepancy could be explained by the authors' experience with this procedure. I congratulate the authors on the good results they achieved using both procedures and for showing us that the minimal access microdiscectomy is a good alternative for surgical management of lumbar disc herniation.

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The authors have performed a randomized, controlled trial examining the differences and similarities between minimally incisional and more standard microdiscectomy techniques. They found that both techniques were effective in affording pain relief and improvements in functional outcome. There were no clinically relevant differences in operative parameters. These results confirm that the important part of the operation is that which occurs relative to the nerve roots and that the technique used to reach the spinal canal is less important. Surgeons should choose a technique that suits their training, experience, and patient population.

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Ryang et al. performed a prospective randomized trial comparing open lumbar discectomy to one performed using a minimally invasive muscle-splitting approach. The two groups were assessed in terms of operative time, blood loss, Visual Analog Pain scores, Oswestry Disability index, and Short Form-36 scores. Complications and reoperations were also reviewed. The outcomes between the two groups were not significantly different in any of the parameters. This is not surprising given the authors' technique for the open procedure. They used the technique described by Caspar (1), which uses a paramedian fascial incision and only partial detachment of the musculature from the hemilamina. This differs significantly from a midline fascial incision and complete unilateral exposure of the spinous processes, laminae, and medial facet of the symptomatic segment. The safety and efficacy of minimally invasive techniques have been well documented, and this report adds to that body of literature. Hopefully, these techniques will ultimately result in a shorter hospital stay for all patients regardless of their locale.

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1. Caspar W: A new surgical procedure for lumbar disk herniation causing less tissue damage through a microsurgical approach. **Adv Neurosurg** 4:74–80, 1977.

The authors have reported a superb effort to provide Class I scientific evidence to the neurosurgical community. By developing a prospective, randomized clinical trial using standardized, validated outcome measures both preoperatively and at defined time periods postoperatively, Ryang et al. have designed an excellent study. Having independent examiners perform postoperative evaluations also strengthens the value of this study. The conclusions reached by the authors are that standard open microsurgical discectomy procedures and minimal access microsurgery produce comparable results. Although no statistically significant benefits were demonstrated in favor of the minimal access surgery, there was a trend in favor of this approach. This study had a relatively high number of disc recurrence/residual herniations. In accordance with the authors' comment on this fact, prospectively following patients in a clinical trial will routinely identify a higher number of adverse events than any retrospective analysis. This is a very useful contribution to the neurosurgical body of knowledge regarding lumbar disc surgery.

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